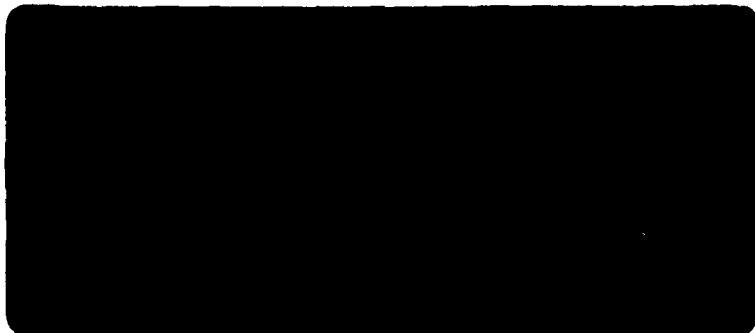


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**Effects of Multiple Cold Air Exposures
on Delayed Matching To Sample Performance**

D. W. Armstrong and J. R. Thomas

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Acute exposure to moderate cold impairs delayed matching to sample (DMS) performance in both animal and man. The effect of multiple cold air ($2.6 \pm 0.6^\circ$) exposures on DMS performance was investigated in this study. Twelve men performed the DMS task during a 45 minute (min) exposure to cold air on Day 1. Oxygen consumption (VO_2) was measured concurrently. After completion of Day 1, subjects were assigned to two groups. Group W performed the DMS task on days 2 to 11 in warm air (22° C) during a 45 min period before sitting in cold air for 45 min. Group C performed the DMS task during a 45 min exposure to cold air on days 2 to 11. On Day 12, all subjects were exposed to cold air as on Day 1. VO_2 was measured concurrently on Days 4 and 8. DMS performance was significantly impaired in all subjects during exposure to cold air on Day 1.			
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when compared to baseline DMS performance. Performance on the DMS was significantly different between the groups on Day 12. Group W performance was different on Day 12 when compared to Day 1. Group C performance was not different from baseline on Day 12 and was significantly improved when compared to Day 1. $\dot{V}O_2$ was elevated in the cold but was not different between groups. $\dot{V}O_2$ was not different on Day 12 when compared to Day 1. DMS is affected by exposure to cold air. Performance on the DMS task improves with repeated air exposure only when the DMS task is repeatedly performed in cold air.

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INTRODUCTION

Exposure to moderate cold temperature is reported to impair performance on various cognitive tasks. Complex cognitive tasks are more likely influenced by cold than are simpler tasks. Prior work has demonstrated a decline in performance on the delayed matching to sample (DMS) task in cold environments. Performance disruption in cold air is influenced by length of delay when compared with DMS performance in a warm environment. The effects of acute cold air exposure on the DMS task are similar in the rat and human models. There is little research regarding the effect of repeated cold exposure on DMS performance or the effect of repeated performance on the DMS task in the cold over successive days.

PURPOSE

The purpose of this study was to investigate the effect of 2.6° C air on DMS performance after 10 consecutive days of practicing the DMS task in contrasting conditions of 22° C or 4° C air. Additionally, the metabolic response to 12 days of repeated 4° C air exposures of 45 minutes duration was investigated.

METHODS

1: To establish a baseline performance, prior to cold exposure, subjects performed at least 10 sessions on the DMS task in warm (22° C) air. The DMS task is performed on a computer as the subject views a 6x6 displayed grid of 36 red and yellow blocks arranged in a random pattern. Two seconds later the screen blanks, and after a delay of 2, 8, or 16 seconds a second display appears. The subject must decide whether the second display is the "same" or "different" from the first display. Each session consists of 99 trials with a random presentation of 33 trials at each delay.

2: On day 1, subjects arrived at the lab after an overnight fast and changed to T-shirt, shorts, and socks. Oxygen consumption was measured during 15 minutes of seated rest with a calibrated SensorMedics 2900 metabolic cart in the dilution mode. The subject then entered a cold air chamber and sat on an open backed chair in front of a computer screen. Maintaining an open body

position, the subject sat for 15 minutes before beginning the DMS task. Total exposure to cold air was 45 minutes. Oxygen consumption was measured continuously.

3: After completion of day 1, subjects were assigned to one of two groups. Six subjects daily performed the DMS task in warm (22° C) air and then entered a cold air chamber and sat quietly for 45 minutes per day for 10 days. Six other subjects daily performed the DMS task in cold (2.6° C) air for a total of 45 minutes duration per day for 10 days.

4: On day 12, subjects repeated the procedures of day 1.

5: All subjects were measured for body composition by use of Lange skinfold calipers. The anatomic sites used were the pectoral, umbilicus, and the mid-thigh.

6: All subjects were tested for maximal aerobic capacity during a continuous graded cycle ergometry test. Oxygen consumption was measured by a calibrated SensorMedics 2900 metabolic cart.

7: SAS 5.18 software was used to analyze the data. Where applicable, one-way ANOVA, covariance, and regression techniques were used to reduce the data. Data are reported as means \pm standard error of the mean; significance was set at $p < .05$.

All testing was completed in the morning after an overnight fast. Subjects, dressed in T-shirt, shorts, and socks, sat quietly for 15 minutes prior to beginning the DMS task. Oxygen consumption was also measured on days 4 and 8.

RESULTS

1: Subject characteristics are listed in Table 1.

2: DMS performance (percent correct) declined significantly in both groups during exposure to cold air on day 1. By day 12, DMS performance for the Cold group had returned to baseline and was not different from baseline at any delay. Performance in the Warm group, however, was significantly decreased from baseline and was not different from the decrease in accuracy observed on day 1 at any delay (Fig. 1, 2, 3, 4).

3: ANOVA, for differences between groups, of the individual slopes and intercepts for percent correct regressed. Days 2 to 11, with day 1 as a covariate, were not different at the 2 and 8 second delays (Fig. 5, 6) but were different at the 16 second delay (Fig. 7). The Cold group responded to the daily cold exposure by improving DMS performance at the 16 second delay, while the Warm group did not demonstrate improvement.

4: Oxygen consumption was not different between groups at rest (3.88 ± 17 ml O_2 /kg/min) or during cold (6.49 ± 0.8 ml O_2 /kg/min) air exposure. Oxygen consumption in warm air or cold air was not different on days 4, 8, or 12 compared with day 1. DMS performance did not affect oxygen consumption.

CONCLUSION

1: Acute exposure to moderate cold air results in a decline in DMS performance when compared with baseline.

2: DMS performance improves with repeated daily practice in a cold environment.

3: Improvement on the DMS task in cold air does not occur with repeated daily practice in a warm environment followed by cold exposure.

4: The metabolic response was not different between sitting quietly in cold air or performing the DMS task in cold air. It was also not different between sitting quietly in warm air or performing the DMS task in warm air.

5: Oxygen consumption was not different within warm or cold air exposure conditions after 12 repeated cold air exposures of 45 minutes duration.

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FIGURE LEGENDS

- Figure 1: Percent correct response at the 2, 8, and 16 second delays on the DMS task at baseline and day 1 to day 12 for the Warm group.
- Figure 2: Percent correct response at the 2, 8, and 16 second delays on the DMS task at baseline and day 1 to day 12 for the Cold group.
- Figure 3: Percent correct response on the DMS task for baseline, day 1, and day 12 at the 2, 8, and 16 second delays for the Warm group.
- Figure 4: Percent correct response on the DMS task for baseline, day 1 and day 12 at the 2, 8, and 16 second delays for the Cold group.
- Figure 5: Percent correct response on the DMS task for the 2 second delay on days 2 to 12 in both groups.
- Figure 6: Percent correct response on the DMS task for the 2 second delay on days 2 to 12 in both groups.
- Figure 7: Percent correct response on the DMS task for the 2 second delay on days 2 to 12 in both groups.

APPENDIX

TABLE 1. SUBJECT CHARACTERISTICS

	WARM	COLD
N	6	6
AGE	30\pm3	31\pm1
HEIGHT	180\pm4	173\pm4*
WEIGHT	77\pm5	72\pm3*
SUM SF	50\pm10	41\pm3
% FAT	15\pm3	13\pm1
HRMAX	176\pm3	178\pm3
V₀₂ PEAK L/MIN	3470\pm298	2863\pm180*
V₀₂ PEAK ML/KG/MIN	43.3\pm4.3	38.5\pm1.6*

MEAN \pm SE

***P<.05**

MATCHING TO SAMPLE

WARM GROUP

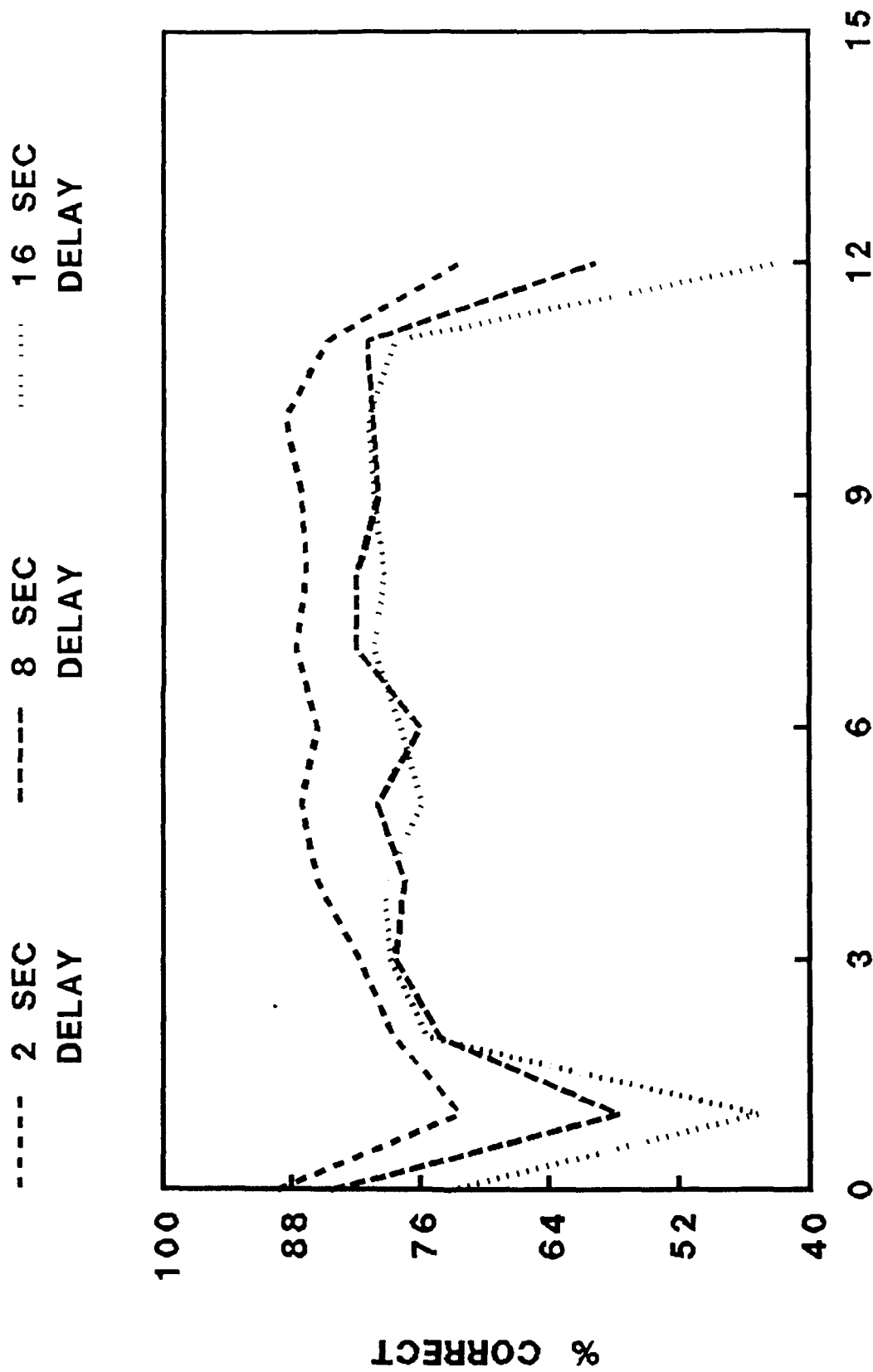


FIGURE 1

MATCHING TO SAMPLE

COLD GROUP

----- 2 SEC DELAY
----- 8 SEC DELAY
..... 16 SEC DELAY

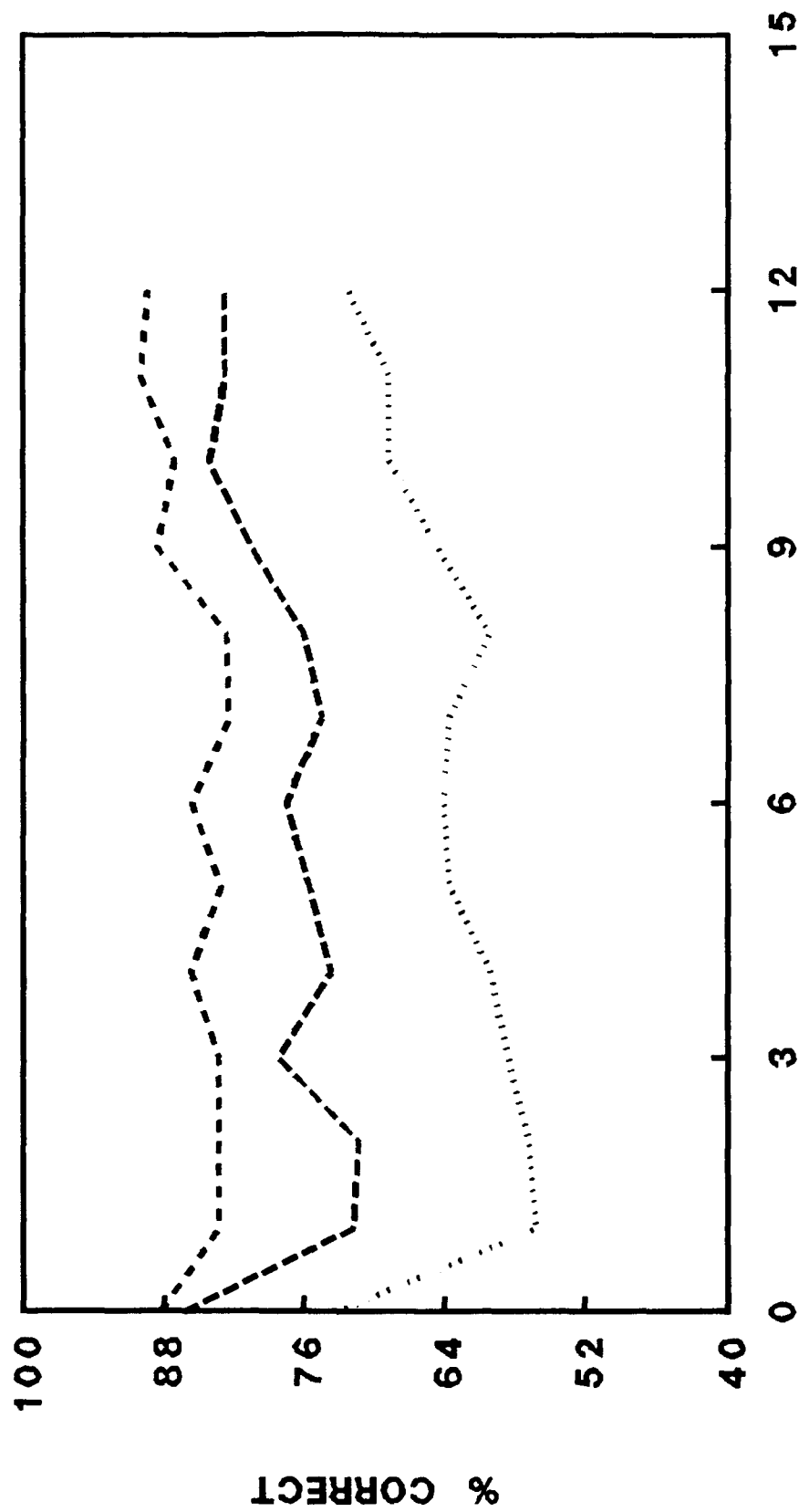


FIGURE 2

MATCHING TO SAMPLE

WARM GROUP

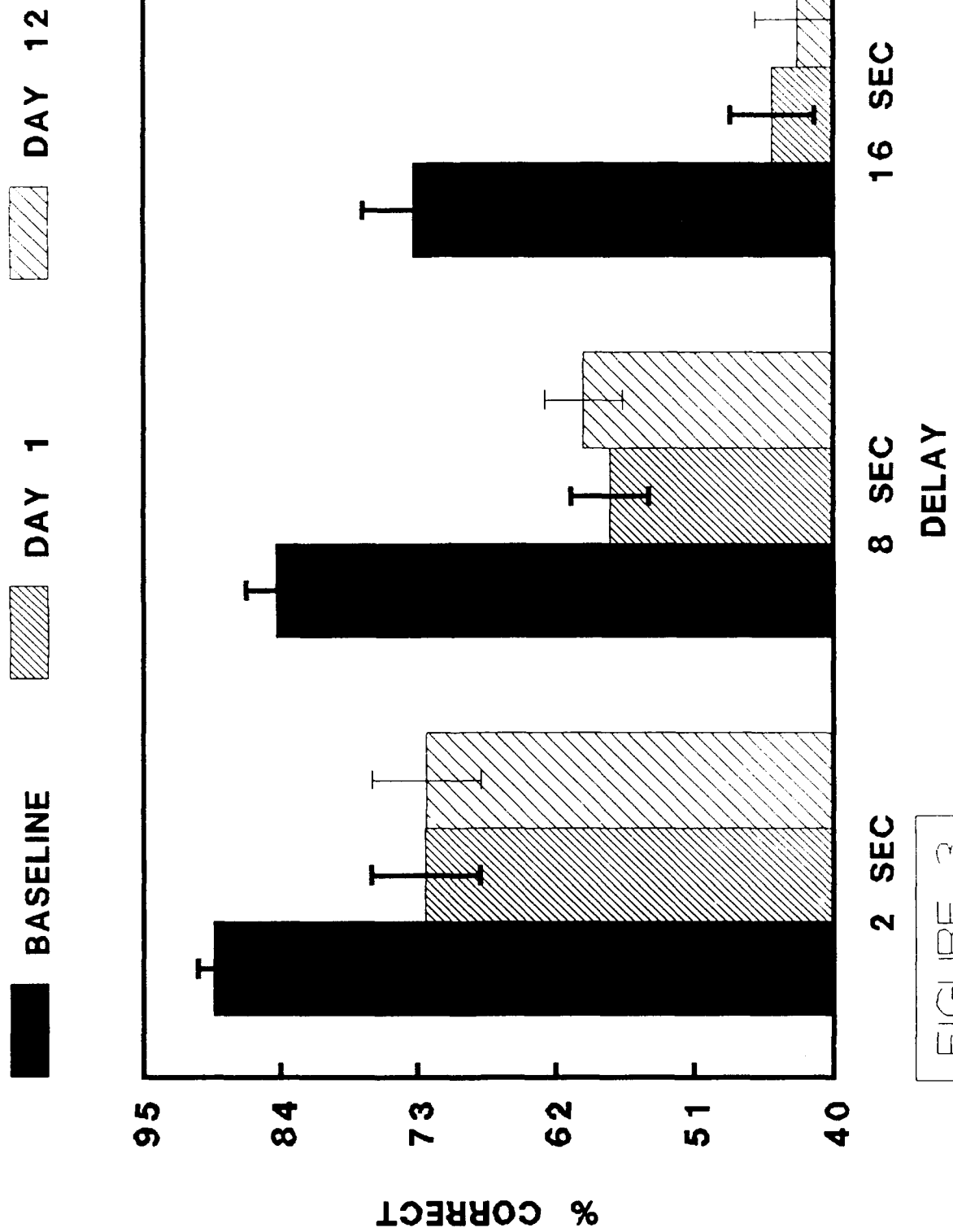


FIGURE 3

MATCHING TO SAMPLE

COLD GROUP

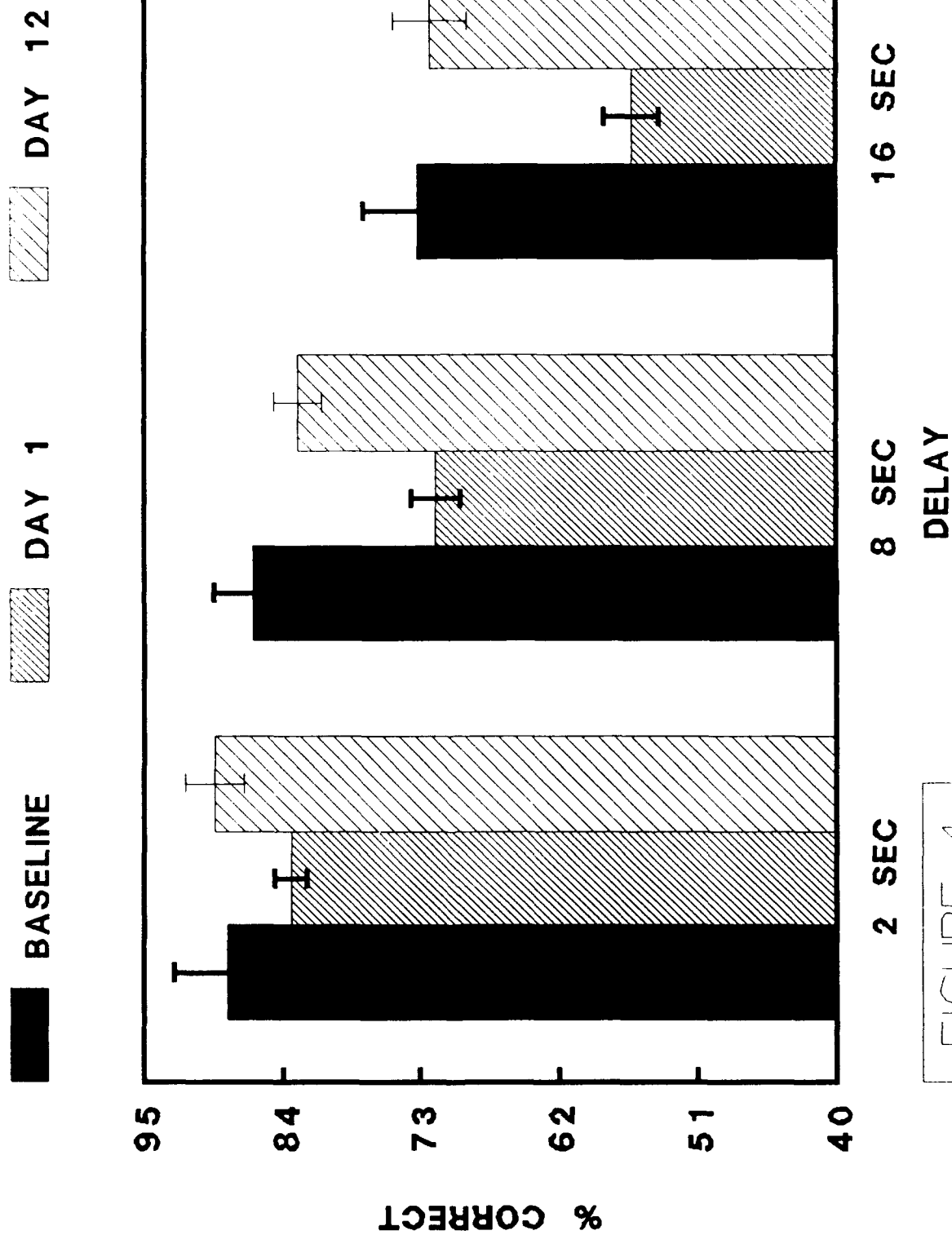


FIGURE 4

MATCHING TO SAMPLE % CORRECT 2 SEC DELAY

— COLD
GROUP

-○- WARM
GROUP

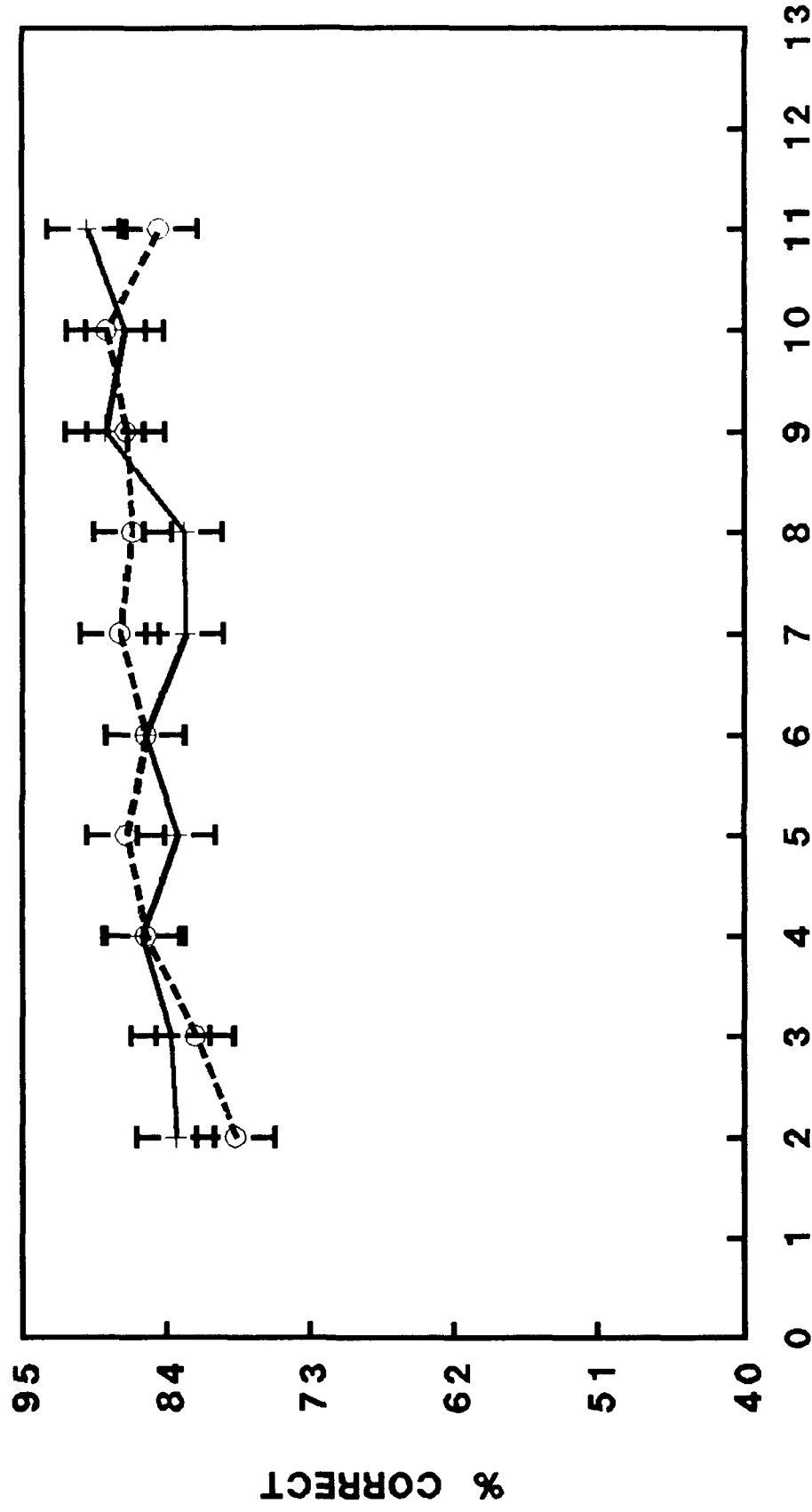


FIGURE 5

MATCHING TO SAMPLE % CORRECT 8 SEC DELAY

— COLD
GROUP

- - - WARM
GROUP

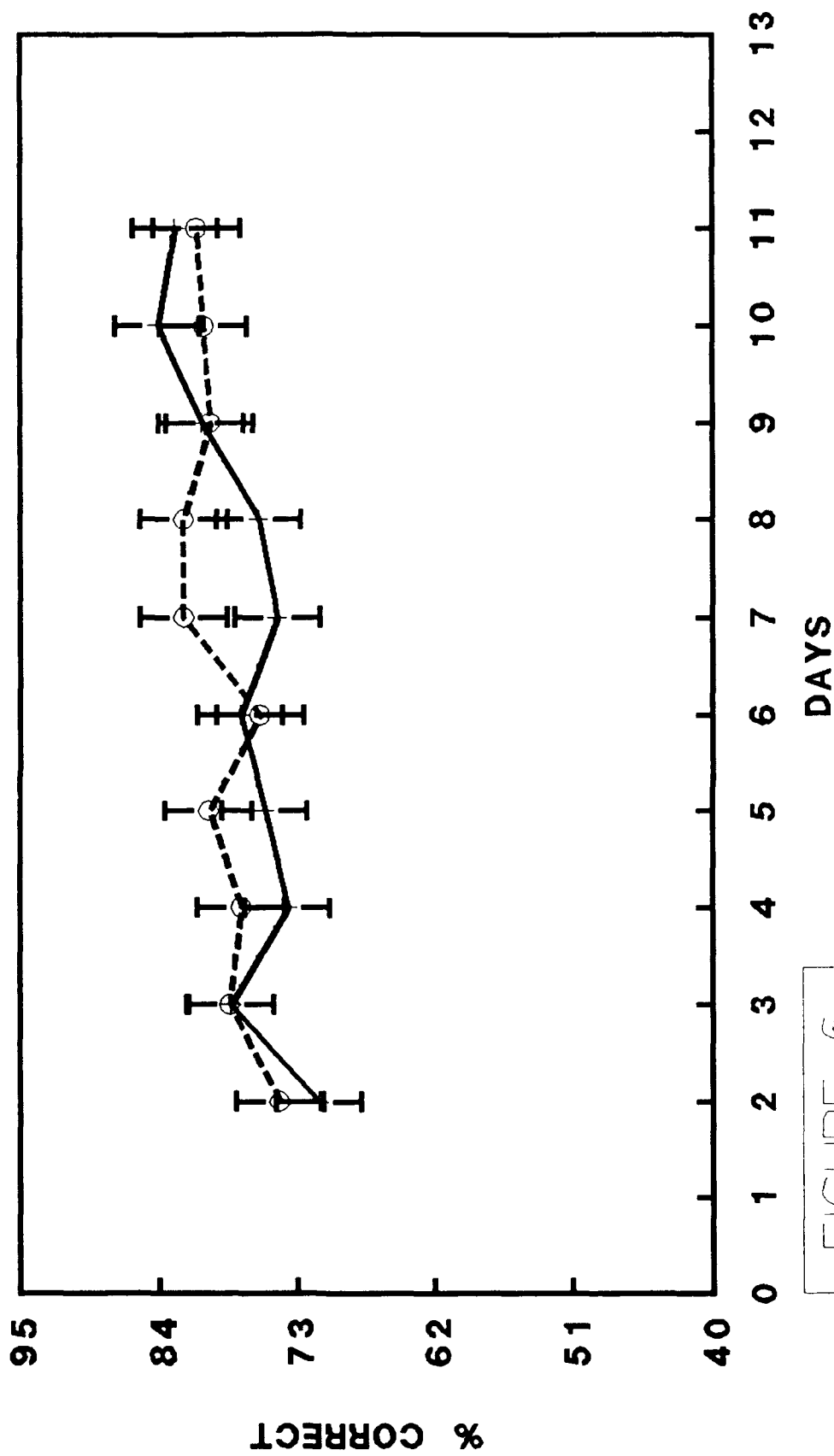


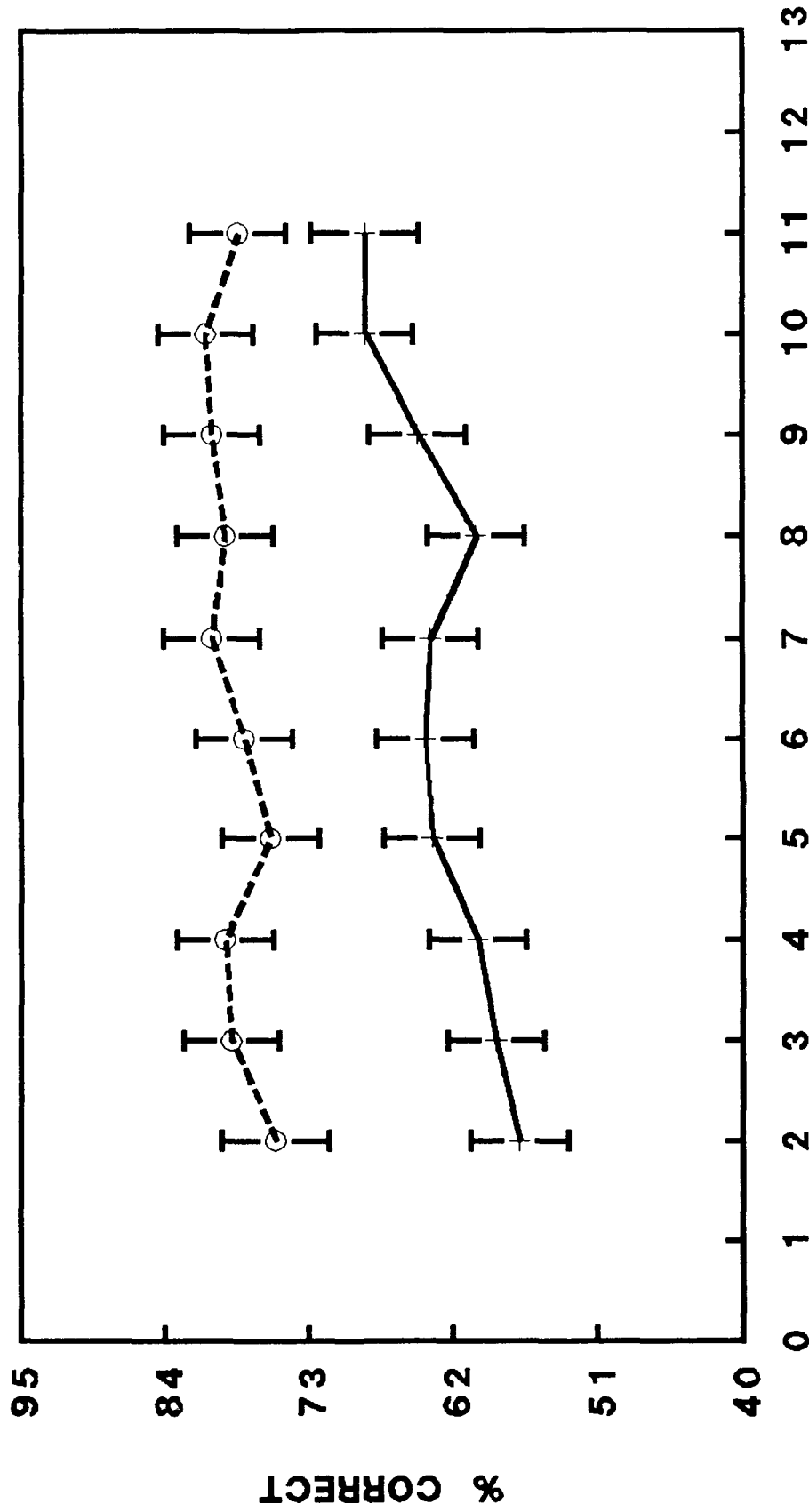
FIGURE 6

MATCHING TO SAMPLE

% CORRECT 16 SEC DELAY

— COLD
GROUP

-○- WARM
GROUP



DAYS

FIGURE 7